

ROS Enabled Communications Between Smartphones & Robot Swarms

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Agenda

- Situation/Objectives
- Background
- System Architecture
- Future work



Situation

- Sharing information
 - Need to share information bi-directionally military and non-military organizations
 - Current operations in Afghanistan
 - HADR
 - NGO's
 - Local government
 - US military has no organic capability to share info
 - Communications must occur outside military networks
- Robots
 - Becoming more prevalent on the battlefield
 - Mostly “tethered” operations



Objectives



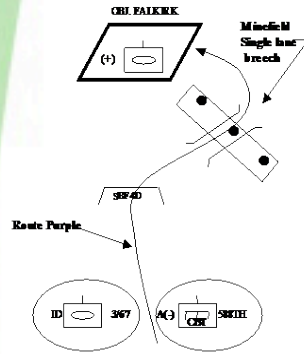
[http://en.wikipedia.org/wiki/File:Afghanistan__American_Soldiers_FOB_Baylough.jpg]

- Implement a swarm of robots controlled by a Smartphone.
- Share information gathered by the swarm based on the commander's need-to-share policy



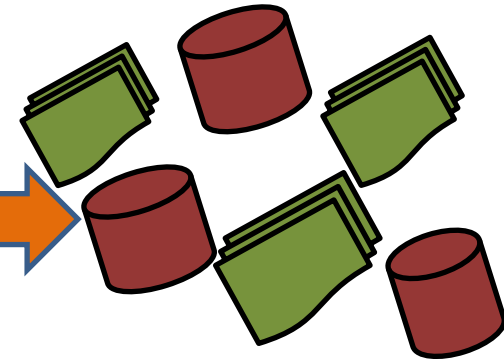
FVI components

Discrete valuing of information

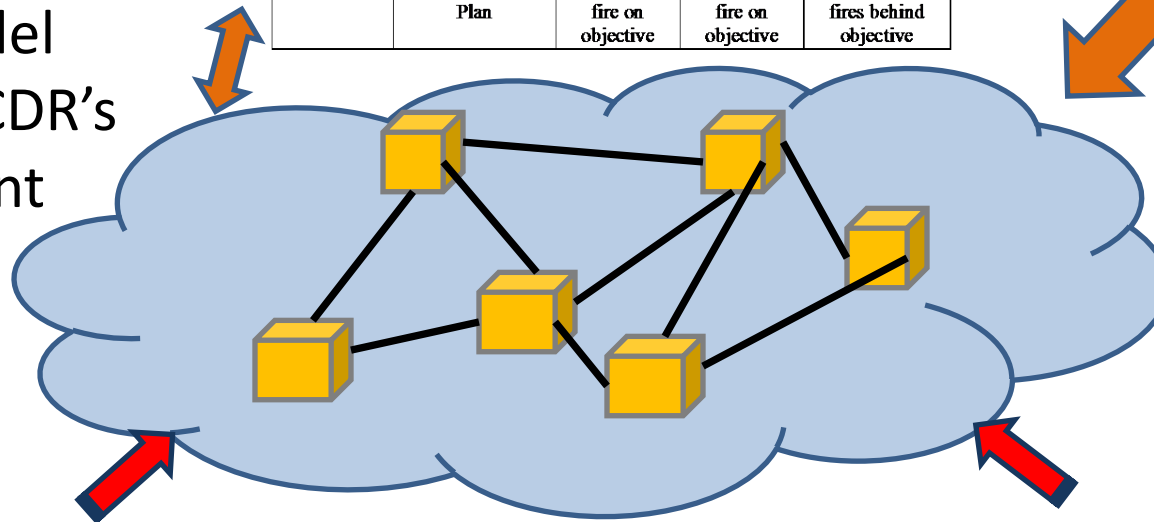


Computable model of CDR's intent

Phase Unit	Phase I (move to LOD)	Phase II (SBF4D)	Phase III (Breach)	Phase IV (Seize obj)
D/3/67 Armor	Occupy positions along LOD	Move to SBF4D	Suppressive fire on objective	Pass through minefield to seize obj
A/3/67 Armor	Occupy positions to feint attack on right flank	Execute feint attack on right flank	Execute feint attack on right flank	Execute feint attack on right flank
B/3/67 Armor	Occupy positions as battalion reserve	Be prepared to assume main attack	Be prepared to assume main attack	Be prepared to assume main attack
A(-)/588 th Engineers	Occupy positions behind D/3/67	Move forward behind D/3/67	Execute single-lane minefield breach	Suppressive fire on objective from SBF4D
Artillery	Execute Fire Plan	Suppressive fire on objective	Suppressive fire on objective	On order shift fires behind objective



Adaptive, cloud-based communications architecture



Need to Share extension to Bell-Lapadula

Formal result

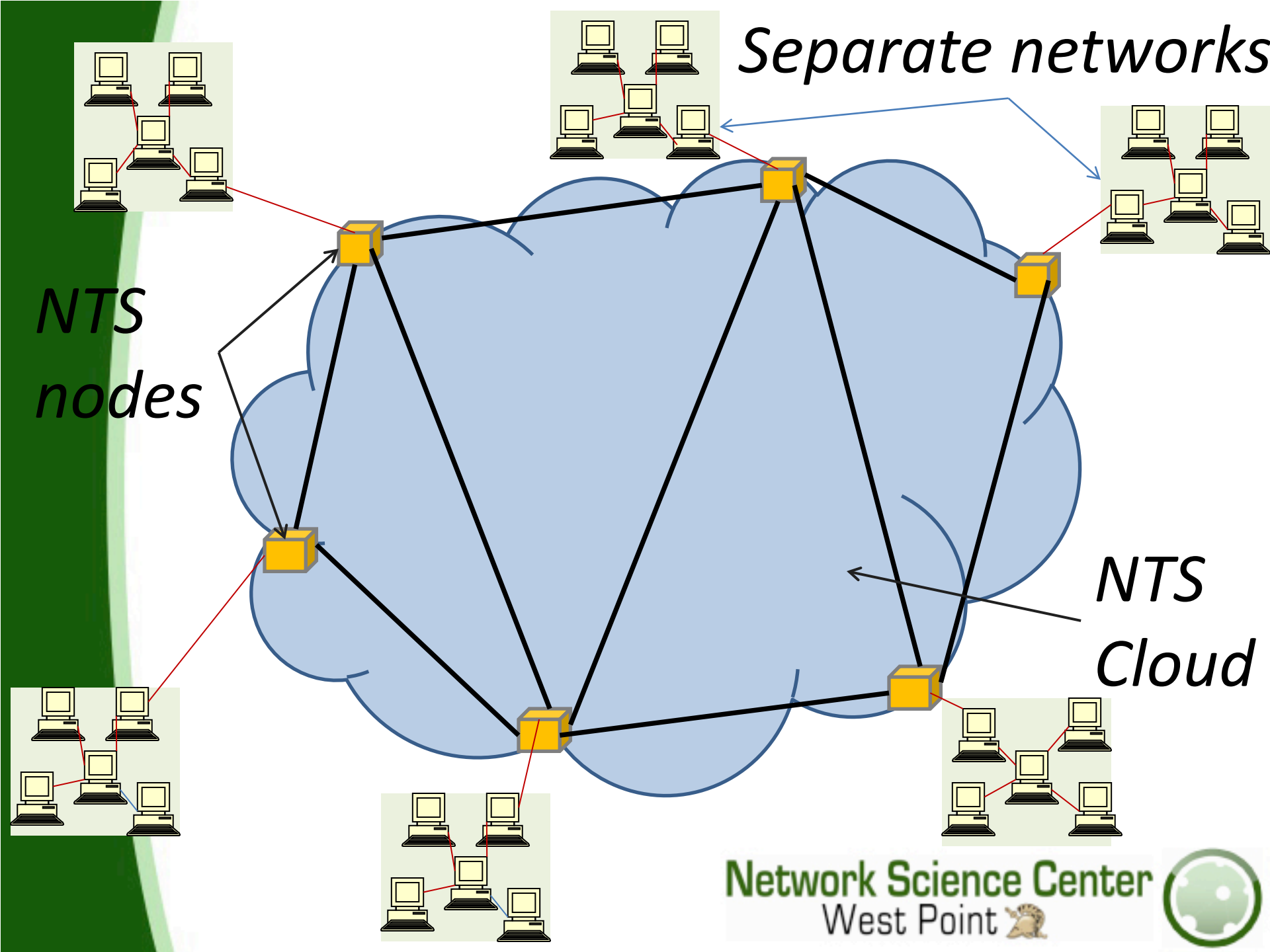


Separate networks

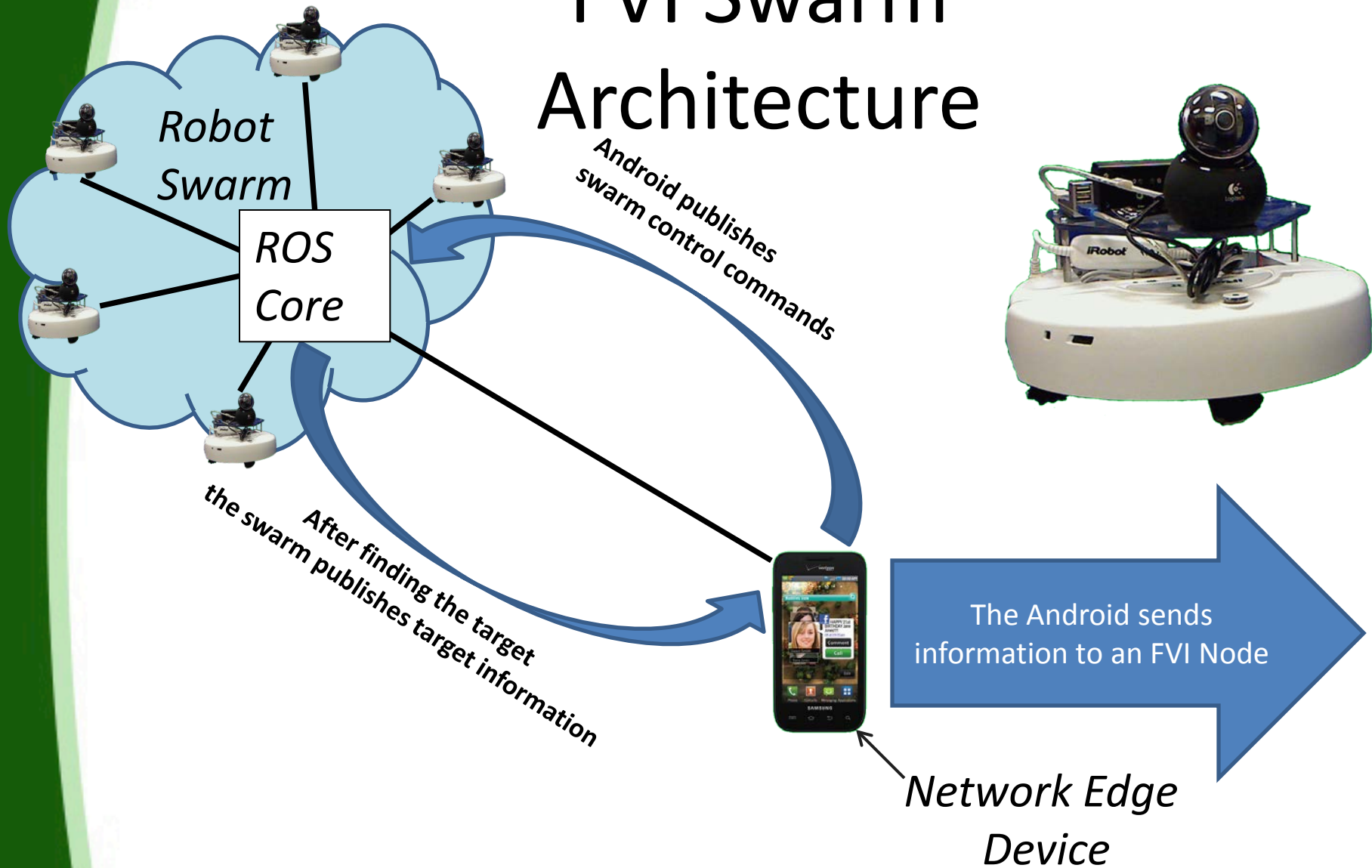
*NTS
nodes*

*NTS
Cloud*

Network Science Center
West Point



FVI Swarm Architecture

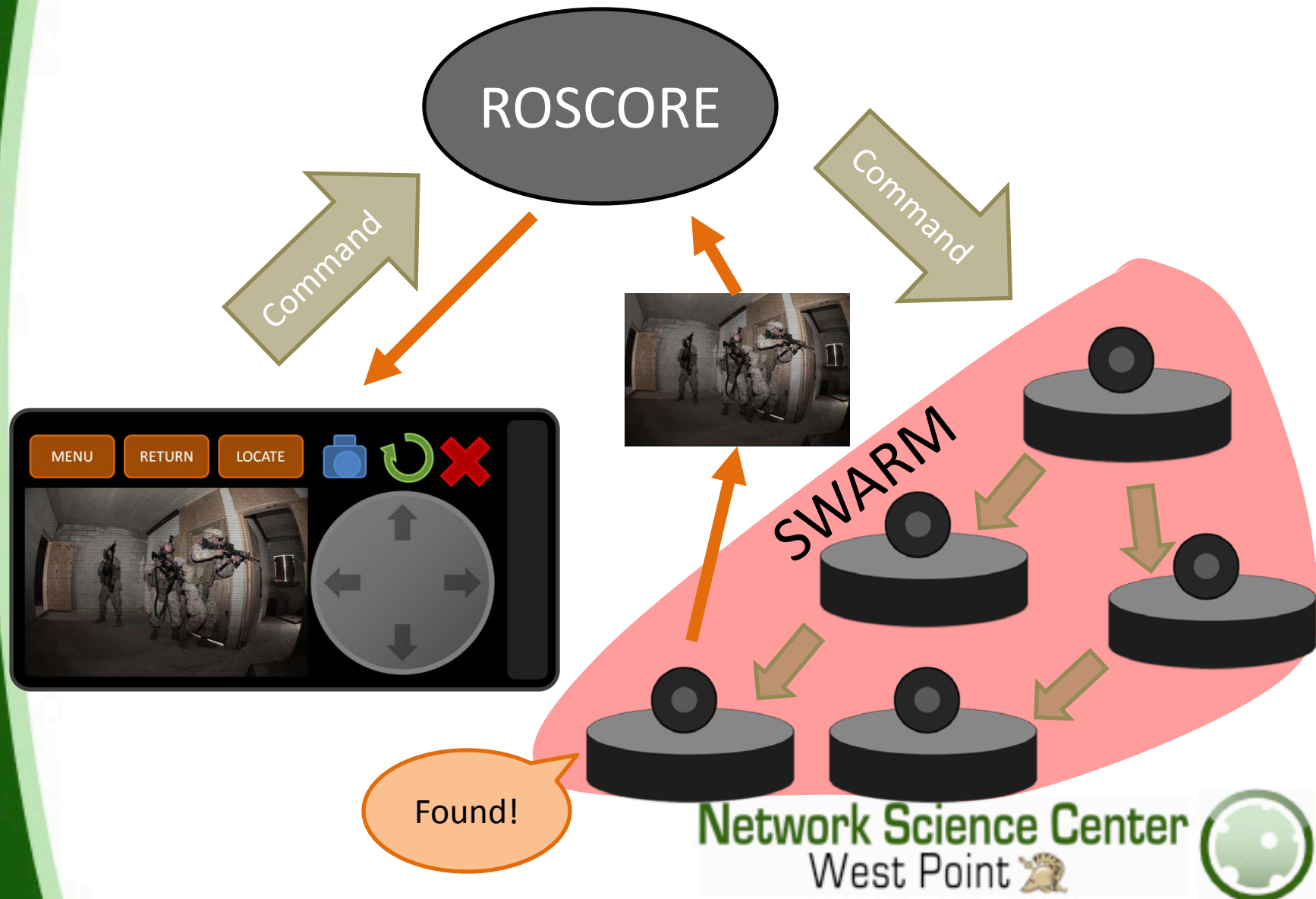


FVI Swarm Features

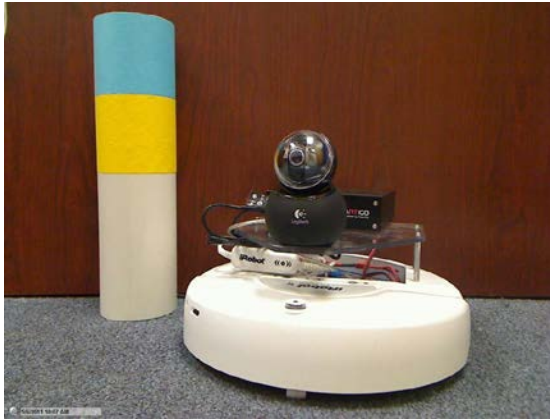
- Small, lightweight device for Soldiers
- Ability to control a single robot or entire swarm
- Ability to receive **and share** information [text, photo, streaming video] from robot
- Familiar interface with Smartphones



ROS-based Swarm Communications Architecture



Robot



- iRobot Create – excellent for research, rapid-prototyping
- Sensors: odometry, collision detection, webcam, LRF, and wireless adapter
- Project not dependent on details of robot – could be substituted for more “battlefield-appropriate” robot in the future



Robot Operating System (ROS)

- Communication framework
- Uses publish/subscribe architecture
- Provides abstraction and permits focus on details of project
- New ROSJava can be used in Android apps

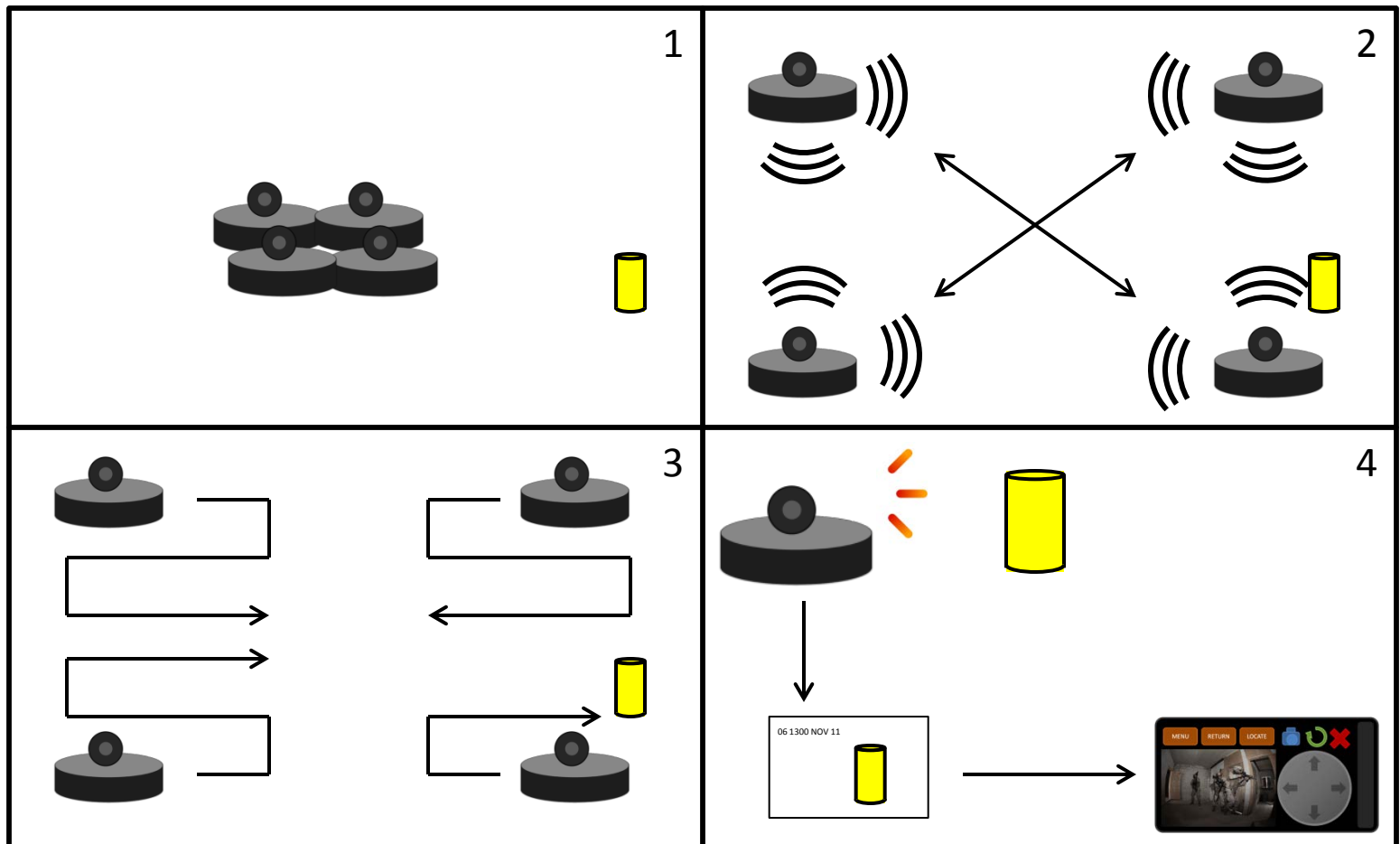


Smartphone

- Google currently working with Willow Garage on ROSJava
- Not all Android versions work
 - Need to root phone to install ROSJava application
 - Android 9 on a Motorola Droid2 did not work
 - Android 10 on a Nexus worked



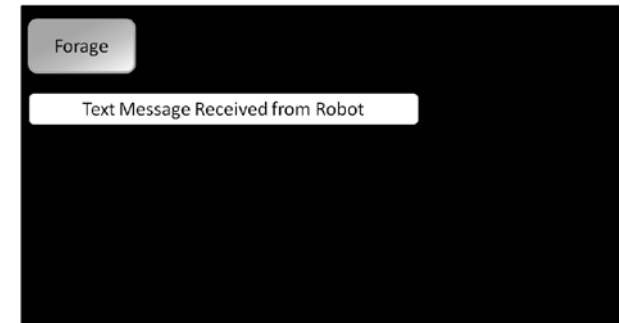
Next Steps: Foraging Algorithm



Next Steps: User Interface

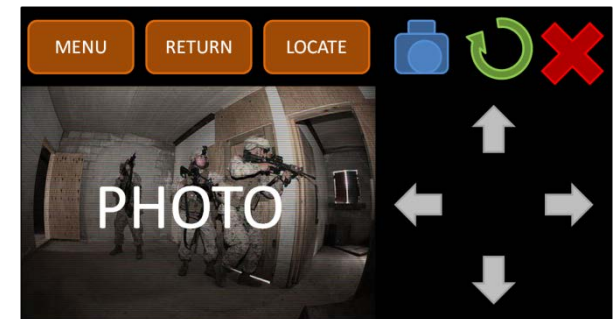
Step 1: Basic Interaction

- Single command
- Text



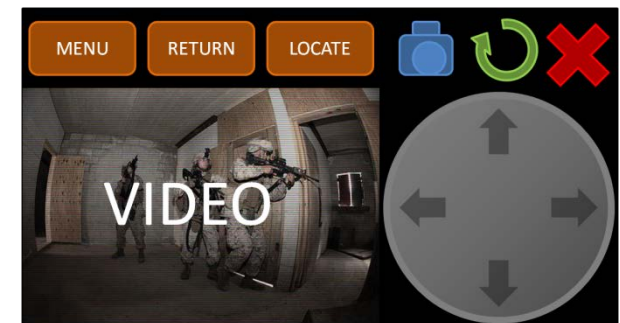
Step 2: Intermediate Interaction

- Discrete directional controls
- Photograph receipt



Step 3: Intermediate Interaction

- Dynamic directional controls
- Video streaming



Future Work

- Infrared communication between robots
- Mapping of an area
- Tilt of Android Device controls camera view



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